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Social comparison affects brain responses to fairness in asset division: an ERP study with the ultimatum game

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Previous studies have shown that social comparison influences individual's fairness consideration and other-regarding behavior. However, it is not clear how social comparison affects the brain activity in evaluating fairness during asset distribution. In this study, participants, acting as recipients in the ultimatum game, were informed not only of offers to themselves but also of the average amount of offers in other allocator–recipient dyads. Behavioral results showed that the participants were more likely to reject division schemes when they were offered less than the other recipients, especially when the offers were highly unequal. Event-related brain potentials recorded from the participants showed that highly unequal offers elicited more negative-going medial frontal negativity than moderately unequal offers in an early time window (270–360 ms) and this effect was not significantly modulated by social comparison. In a later time window (450–650 ms), however, the late positive potential (LPP) was more positive for moderately unequal offers than for highly unequal offers when the other recipients were offered less than the participants, whereas this distinction disappeared when the other recipients were offered the same as or more than the participants. These findings suggest that the brain activity in evaluating fairness in asset division entails both an earlier (semi-) automatic process in which the brain responds to fairness at an abstract level and a later appraisal process in which factors related to social comparison and fairness norms come into play.

Keywords: social comparison, fairness consideration, ultimatum game, ERP, MFN, LPP

INTRODUCTION

Fairness is important in interpersonal interaction and for social stability. A large number of studies, employing different paradigms, show that people demand fairness in wealth allocation and are willing to sacrifice economic interests to punish unfair behavior (Fehr and Gächter, 2002; Camerer, 2003). One way to investigate fairness consideration in asset division is to let individuals play economic exchange games, like the ultimatum game (UG; Güth et al., 1982), and to examine these individuals' behavioral responses and/or brain activities. In the standard UG, two players have to divide a certain amount of money between them. One player is the allocator and proposes a division of the money; the other is the recipient and can either accept or reject the division scheme. If the recipient accepts, the asset is divided as proposed. If the recipient rejects, both players end up empty-handed. Ample evidence shows that allocators often offer an equal split, and that recipients are unwilling to accept offers that leave them with approximately 20% of the pie or less (Camerer and Thaler, 1995). Studies manipulating the size of the bargaining property and the population of players obtain essentially the same pattern of effects (Hoffman et al., 1996; Henrich et al., 2006).

As the UG is a typical dyadic bargaining situation, the recipient automatically compares the amount offered to him with the amount the allocator would have, and this comparison helps the recipient to judge whether the division scheme is fair (Handgraaf et al., 2003). If the amount offered to the recipient compares unfavorably to the amount left to the allocator, negative feelings are elicited, and drive the recipient to reject the offer (Sanfey et al., 2003). In daily life, however, individuals may focus not only on the outcomes of those who are involved in the current negotiation, but also on the outcomes of people who are in similar roles but in different negotiations (Loewenstein et al., 1989). For example, in salary negotiations, prospective employees typically do not compare their wages with those of their employers, but rather with wages of similarly situated employees (Babcock et al., 1996). Bohnet and Zeckhauser (2004) termed the comparison in UG between recipients in different allocator–recipient dyads as *social comparison*, and found it to affect both the allocator's and the recipient's bargaining behavior. In particular, when recipients were informed of the average offer of allocators in other allocator–recipient dyads, the allocators were more likely to propose higher offers and the recipients were more likely to reject unequal offers. They suggested that social comparison could highlight and facilitate attention to fairness norms and affect fairness consideration and other-regarding behavior in strategic situations.

Note that social comparison can be in different directions (Festinger, 1954): an upward comparison in which individuals compare themselves with peers in a better standing; a downward comparison in which individuals compare themselves with peers in an inferior situation; and a lateral comparison in which individuals compare themselves with peers in similar standings. Downward and upward comparisons may lead to different emotional responses, including schadenfreude and envy (Takahashi et al., 2009). They may also affect, in different ways, how individuals respond to unequal division of asset.

The main purpose of this study was therefore to investigate how upward and downward social comparison modulates the recipient's fairness consideration in asset division and how the brain responds to such modulations. Previous studies have demonstrated that brain regions such as ventral striatum and/or ventromedial prefrontal cortex are involved in the social comparison process (Fliessbach et al., 2007; Takahashi et al., 2009; Dvash et al., 2010; Tricomi et al., 2010), and these brain activities are modulated by individual differences, such as social value orientation (Haruno and Frith, 2010). What is lacking is the detailed knowledge about the temporal characteristics of neural processes involved in social comparison and its modulation on fairness consideration (see Qiu et al., 2010; Boksem et al., 2011). Here we developed a variant of UG in which the participant, acting as a recipient in asset division, was informed not only about the amount of money (out of 10 Chinese yuan) offered to him by the allocator in his own allocator–recipient dyad but also the average amount offered to recipients in other allocator–recipient dyads. While the offer to the participants could be moderately unequal (4 out of 10 yuan) or highly unequal (2 out of 10 yuan), a downward comparison was made possible by the presented average amount of offers in other dyads being 3 or 1 yuan, respectively; similarly, an upward comparison was made possible by the average amount being 5 or 3 yuan, respectively. From a rational perspective, the potential social comparison should not affect the participant's decision to accept or reject the offer as interests of the participant and of other recipients were independent from each other. However, it has been demonstrated that fairness consideration is strongly context-dependent and is constrained by various social or situational factors (Handgraaf et al., 2003; Güroglu et al., 2010). It was likely that the upward (and perhaps the downward) comparison would affect the participant's decision to accept or reject the offers, especially when the offer was highly unequal.

Electrophysiologically, we focused on the medial frontal negativity (MFN), an Event-related brain potential (ERP) component that has been implicated in the evaluation of fairness in asset distribution. The MFN is a negative deflection peaking between 200 and 350 ms at frontocentral recording sites. It has been found to be sensitive to violation of social expectancy or social norms (Polezzi et al., 2008; Boksem and De Cremer, 2010; Hewig et al., 2011; Wu et al., 2011; Van der Veen and Sahibdin, 2011). Unequal offers, i.e., offers deviating from the equal division of asset, elicit more negative-going MFN than equal offers in economic exchange games. The MFN is also more pronounced for lower offers than for higher offers and this effect is especially true for participants with high concerns for fairness (Boksem and De Cremer, 2010). For the present study, we would predict that highly unequal offers could elicit more negative MFN responses than moderately unequal offers, reflecting a general violation of social expectancy. Moreover, we predicted that social comparison could modulate the MFN effect for different offers. Boksem et al. (2011) found that the MFN effect for monetary gains and losses associated with outcomes in a time-estimation task is more pronounced when an individual's own reward is worse than that for others. We therefore hypothesized that highly unequal offers (2 out of 10 yuan) would elicit stronger MFN effect when the participants were offered less than the average amount of offers (3 yuan) to the recipients in other allocator–recipient dyads, as upward comparison might strengthen the negative motivational/affective significance of the highly unequal offers.

Another ERP component, the P300, which is the most positive peak in the period of 200–600 ms, has also been found to be related to various aspects of outcome evaluation or reward processing. Some studies found that the P300 is sensitive to the magnitude of reward, with a more positive response to a larger than to a smaller reward (Yeung and Sanfey, 2004; Sato et al., 2005). Other studies suggested that the P300 is also sensitive to reward valence, with a more positive amplitude for positive than for negative reward (Hajcak et al., 2005, 2007; Yeung et al., 2005; Wu and Zhou, 2009; Leng and Zhou, 2010). In a study on asset division, Wu et al. (2011) found that the P300 is more positive to equal offers than to unequal offers. Thus one might predict a similar pattern for the P300 in this study, although it was not clear how social comparison might modulate the pattern of the P300 effect. On the other hand, Qiu et al. (2010) asked participants to perform a number estimation task and to receive feedback on their own as well as others' monetary reward associated with performance. They obtained an effect on sustained late positivity potential (LPP) rather than the P300, for lateral, upward, and downward comparisons. It has been suggested the LPP may have functional significance similar to that of the P300 (Ito et al., 1998). It was not clear whether we would observe an LPP or P300 effect for offer type and/or for social comparison.

MATERIALS AND METHODS

PARTICIPANTS

Twenty-six undergraduate and graduate students (19 females; mean age 21.92 years, SD = 2.00) participated in the experiment. Seven students, who were strangers to the participants, were recruited as confederates. The purpose of using seven confederates was to reduce the reputation building effect in the repeated-trial game and to make the experimental setup more realistic since the participant would play against different allocators in rounds of the game.

All the participants were right-handed and had normal or corrected-to-normal vision. They had no history of neurological or psychiatric disorders. Informed consent was obtained from each participant before the test. The experiment was performed in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of the Department of Psychology, Peking University. Each participant was paid 45 Chinese yuan (about $ 6.9) as basic payment and was informed that additional monetary reward would be paid according to their performance in the task, although in the end all the participants were paid extra 5 yuan on top of the basic payment.

DESIGN AND PROCEDURES

The experiment had a 2 × 3 within-participant factorial design, with the first factor referring to offer type (moderately unequal vs. highly unequal) and the second factor referring to social comparison (downward vs. lateral vs. upward). A highly unequal offer was 2 out of 10 yuan and a moderately unequal offer was 4 out of 10 yuan. For upward or downward comparison condition, the average amounts of offers to recipients in other allocator–recipient dyads were 1 yuan more or less than the offers to the participants, whereas for lateral comparison, the average amounts were equal to the offers to the participants.

When a participant came to the laboratory, he/she and the seven confederates were told that they would sit in separate rooms to finish a task together through the computer network. By assigning the participant and the confederates pre-determined cards, they were ostensively led to separate cubicles to play different roles in the game. The participant was then told that he/she as well as another three randomly selected participants would play as recipients in UG and the other four would play as allocators. He/she was also informed about the rules of the experiment. That is, at the beginning of each round, the computer would randomly pair each recipient with one allocator, and the allocator would then make an offer on how to divide 10 yuan. Offers in the four different dyads were independently and simultaneously made by the allocators. The participant was presented with not only the amount his/her paired allocator proposed to offer but also the average amount of offers in the other three allocator–recipient dyads. The participant was asked to press a button with the index finger of his/her left or right hand, without elaborative thinking, to indicate whether he/she would accept or reject the offer. Note that the participant was reminded that his/her response to each offer would not be sent back to the allocator immediately and therefore would not affect the allocators' offers in the following rounds.

Each trial began with the presentation of a photo of the 10 yuan bill (2.6° × 1.3°) for 500 ms against a black background (see **Figure 1**). The sentence "The computer is randomly pairing" in Chinese (white and Song font, size 32) was presented for another 500 ms, indicating to the participant that four different dyads were being formed randomly. Then the sentence "Please wait for the offer" in Chinese (white and Song font, size 32) was presented for either 500, 750, 1000, 1250 ms, implying that the allocators were considering how to distribute the assets. After the presentation of a blank screen for a period of either 400, 500, 600, or 700 ms, the amount offered to the EEG participant as well as the average amount offered in other dyads (i.e., the division scheme) were revealed in two lines of words (e.g., "you 2, average 2," white and Song font, size 32) at the center of screen for 1000 ms. The screen turned blank again for 400 ms, followed by the presentation of two options, "accept" and "reject" (in words), on the left and right side of the screen respectively, with the positions of the two options counterbalanced over participants. The participant was asked to make the "accept" or "reject" decision as quickly as possible and his/her choice was highlighted by thickening the white outlines of the option. The next trial began 1000 ms after the button press.

The participant was seated comfortably about 1.5 m in front of a computer screen in a dimly lit room. The experiment was administered on a computer with a Del 22-in. CRT display, using Presentation software (Neurobehavioral System Inc.) to control the presentation and timing of the stimuli. Without the participant's knowledge, all the offers were pre-determined by a computer program. Each of the six experimental conditions had 40 trials. In addition, another 120 trials, with the average offers (up to one decimal place) computed according to different possible offers, were used as fillers. The 360 trials were randomly mixed and were divided in equal numbers into 3 blocks. A practice block of 9 trials was administered before the formal test to familiarize the participants with the task. Participants were debriefed, paid, and thanked at the end of the experiment.

EEG RECORDING AND ANALYSIS

EEGs were recorded from 64 scalp sites using tin electrodes mounted in an elastic cap (Brain Products, Munich, Germany) according to the international 10–20 system. The vertical electrooculogram (VEOGs) was recorded supra-orbitally from the right eye. The horizontal EOG (HEOG) was recorded from electrodes placed at the outer canthus of the left eye. All EEGs and EOGs were referenced online to an external electrode which was placed on the tip of nose and were re-referenced offline to the mean of the left and right mastoids. Electrode impedance was kept below 10 kΩ for EOG channels and below 5 kΩ for all other electrodes. The bio-signals were amplified with a bandpass from 0.016 to 100 Hz and digitized online with a sampling frequency of 500 Hz.

Separate EEG epochs of 1000 ms (with a 200-ms pre-stimulus baseline) were extracted offline, time-locked to the onset of each division scheme. Ocular artifacts were corrected with an eye-movement correction algorithm that employs a regression analysis in combination with artifact averaging (Semlitsch et al., 1986). Epochs were baseline-corrected by subtracting from each sample the average activity of that channel during the baseline period. All the trials in which EEG voltages exceeded a threshold of ±80 μV during recording were excluded from further analysis. For highly unequal offers, on average 36.36 (SD = 4.51), 35.81 (SD = 5.21), and 35.91 (SD = 4.96) trials after artifact rejection were entered into statistical analysis for the downward, lateral, and upward social comparison conditions, respectively. For moderately unequal offers, on average 36.91 (SD = 4.57), 36.09 (SD = 5.07), and 35.82 (SD = 4.55) trials were left for the three conditions, respectively. The number of trials did not differ between conditions after artifact rejection. The EEG data were low-pass filtered below 30 Hz.

For the MFN, we focused on 10 frontal electrodes, F3, F1, Fz, F2, F4, FC3, FC1, FCz, FC2, and FC4. For the LPP, we focused on these same frontal electrodes as well as 10 posterior electrodes, CP3, CP1, CPz, CP2, CP4, P3, P1, Pz, P2, and P4. We ct, nnc en-0003 Tc[

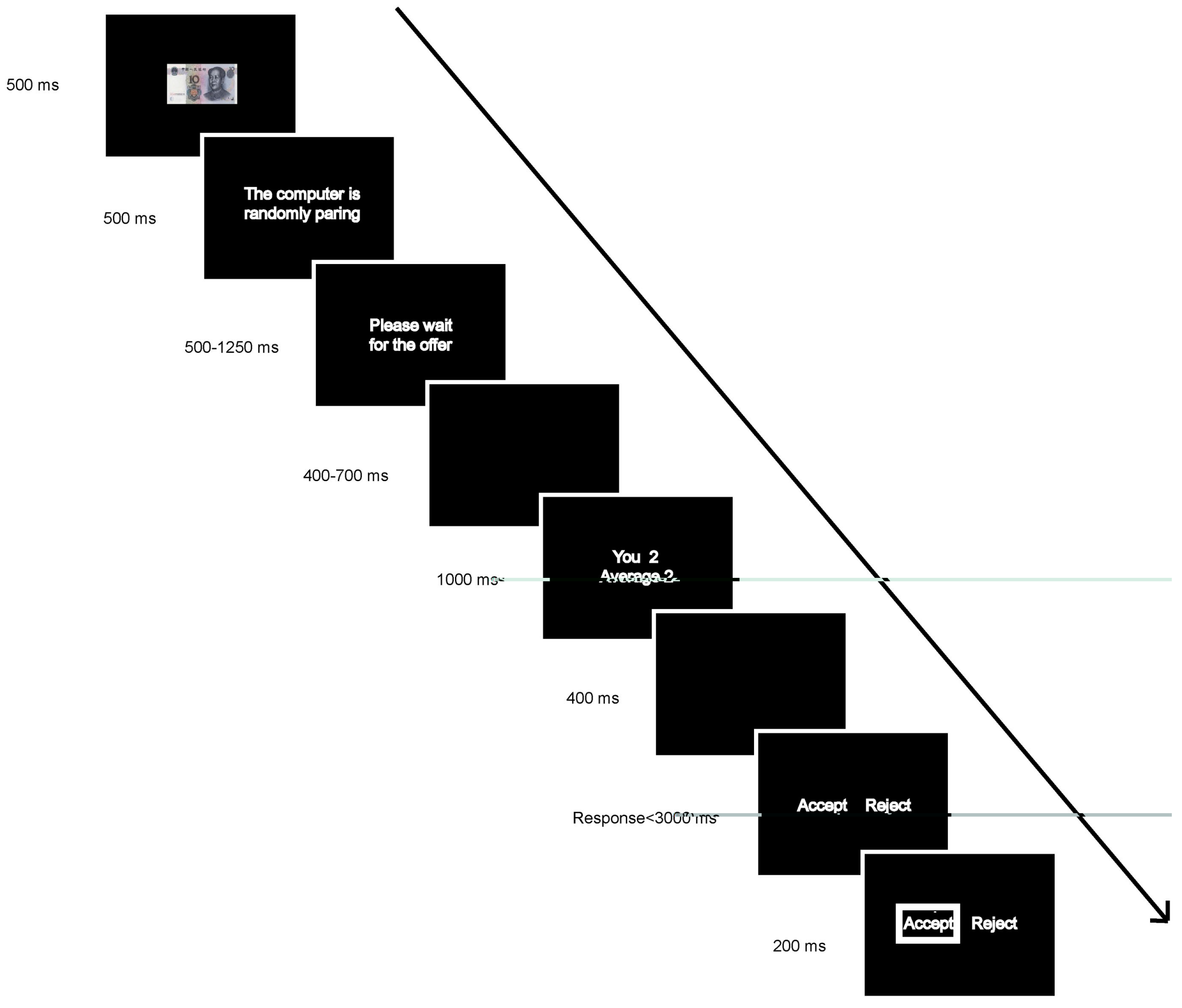

FIGURE 1 | Sequence of events in a single trial.

according to visual inspection of waveforms. Analyses of variance (ANOVAs) were conducted with three within-participant factors: offer type (highly unequal vs. moderately unequal), social comparison (upward vs. lateral vs. downward), and electrode. If the interaction between offer type and social comparison reached statistical significance, further *F* tests were conducted to test the simple effects, with electrode as a factor of no-interest. The Greenhouse–Geisser correction for violation of the assumption of sphericity was applied where appropriate. The Bonferroni correction was used for multiple comparisons.

RESULTS

Among the 26 EEG participants, one participant accepted all the offers and three participants displayed excessive artifacts in EEG recording. These participants were excluded from data analysis, leaving 22 participants for the following analysis.

BEHAVIORAL RESULTS

Rejection rates for different division schemes are presented in **Figure 2.** A 2 (offer type: highly unequal vs. moderately unequal) × 3 (social comparison: downward vs. lateral vs. upward) repeated-measures ANOVA revealed a significant main effect of offer type, $F(1,21) = 50.24$, $p < 0.001$, $\eta^2 = 0.71$, indicating that rejection rate for highly unequal offers (mean ± SD, 0.54 ± 0.30) was higher than that for moderately unequal offers (0.07 ± 0.11). The main effect of social comparison was significant, $F(2,42) = 18.07$, $\varepsilon = 0.69$, $p < 0.001$, $\eta^2 = 0.46$, suggesting that the rejection rate was higher for upward comparison (0.48 ± 0.25) than for either lateral (0.25 ± 0.20) or downward (0.20 ± 0.19) comparison, as confirmed by *post hoc* tests, $ps < 0.001$. Rejection rates for lateral and downward comparison did not differ from each other, $p > 0.1$. Importantly, these main effects were qualified by a significant interaction between offer

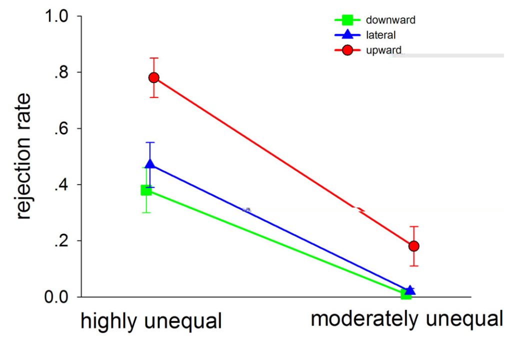

FIGURE 2 | The rejection rate depicted as a function of offer type and social comparison. Error bars represent standard errors of the means.

type and social comparison, $F(2,42) = 5.57$, $\varepsilon = 0.90$, $p = 0.01$, $\eta^2 = 0.21$. Further tests showed that for highly unequal offers, there was a main effect of social comparison, $F(2,42) = 18.20$, $p < 0.001$, $\eta^2 = 0.46$, with the rejection rate being higher for upward comparison (0.78 ± 0.31) than for either lateral (0.47 ± 0.39) or downward comparison (0.38 ± 0.37), *ps* < 0.001; for moderately unequal offers, the main effect of social comparison was also significant, $F(2,42) = 6.71$, $p < 0.05$, $\eta^2 = 0.24$, with the rejection rate being higher for upward (0.18 ± 0.31) than for downward comparison (0.01 ± 0.04), $p < 0.01$. Thus, the rejection rate was enhanced for upward comparison, and this was especially the case when the offers to the participants were highly unequal (**Figure 2**).

THE MFN

For the mean amplitudes in the 270- to 360-ms time window (**Figures 3A,B**), ANOVA revealed a significant main effect of offer type, $F(1,21) = 25.28$, $p < 0.001$, $\eta^2 = 0.55$, indicating that ERP responses were more negative going for highly unequal offers (mean ± SD, $0.35 \pm 3.06\,\mu$V) than for moderately unequal offers ($1.25 \pm 3.16\,\mu$V). However, there was no significant main effect of social comparison, $F(2,42) = 1.74$, $p > 0.1$, nor interaction between offer type and social comparison, $F(2,42) = 1.48$, $p > 0.1$, indicating that social comparison did not affect the manifestation of the MFN.

THE LATE POSITIVE POTENTIAL

At the frontal region, ANOVA revealed no significant main effect of offer type, $F(1,21) = 1.99$, $p > 0.1$, but a significant main effect of social comparison for the mean amplitudes in the 450- to 650-ms time window, $F(2,44) = 6.72$, $\varepsilon = 0.98$, $p < 0.01$, $\eta^2 = 0.24$, suggesting that the LPP was less positive for downward ($1.53 \pm 3.24\,\mu$V) and upward comparison ($1.46 \pm 3.44\,\mu$V) than for lateral comparison ($2.56 \pm 3.19\,\mu$V), $p < 0.05$ and $p < 0.01$, respectively. Moreover, this main effect was qualified by a significant interaction between offer type and social comparison, $F(2,42) = 3.36$, $\varepsilon = 0.95$, $p < 0.05$, $\eta^2 = 0.14$. Further tests showed that moderately unequal offers ($2.17 \pm 3.51\,\mu$V) elicited more positive-going responses than highly unequal offers ($0.90 \pm 3.18\,\mu$V) in downward comparison (**Figure 3C**), $F(1,21) = 11.93$, $p < 0.01$, $\eta^2 = 0.36$, whereas this contrast did not produce significant effects for either lateral or upward comparison, both $F(1,21) < 1$. On the other hand, for moderately unequal offers, social comparison did not affect LPP responses, $F(2,42) = 2.52$, $\varepsilon = 0.99$, $p = 0.09$; for highly unequal offers, social comparison did have a significant effect, $F(2,42) = 9.63$, $\varepsilon = 0.96$, $p < 0.001$, $\eta^2 = 0.31$, with LPP for downward ($0.90 \pm 3.18\,\mu$V) and upward comparison ($1.53 \pm 3.53\,\mu$V) being less positive-going than for lateral comparison ($2.61 \pm 3.12\,\mu$V), $p < 0.01$ and $p < 0.05$, respectively.

At the posterior region, ANOVA revealed only a significant main effect of social comparison, $F(2,42) = 5.33$, $\varepsilon = 0.92$, $p = 0.01$, $\eta^2 = 0.20$, indicating that the mean amplitudes were less positive for upward comparison ($5.63 \pm 3.14\,\mu$V) than for lateral comparison ($6.76 \pm 2.96\,\mu$V), $p < 0.01$. The mean amplitudes for lateral comparison were intermediate ($6.\ 12 \pm 2.86\,\mu$V) and did not differ significantly from other conditions, *ps* > 0.1. Neither the main effect of offer type nor the interaction between offer type and social comparison was significant, $F(1,21) = 1.49$, $p > 0.1$, and $F(2,42) = 1.39$, $p > 0.1$, respectively.

DISCUSSION

This study demonstrated that social comparison influences recipients' behavioral reactions as well as their brain responses to unequal asset allocation schemes in the UG. Participants were more likely to reject division schemes when the recipients in other dyads were offered more than themselves (i.e., upward comparison), particularly when the offers were highly unequal. Electrophysiologically, highly unequal offers elicited more negative-going ERP responses than moderately unequal offers in an earlier MFN time window (270–360 ms), and this effect was not modulated by social comparison. In a later time window (450–650 ms), the late positive potential (LPP) was more positive for moderately unequal offers than for highly unequal offers when the other recipients were offered less than the participants were (i.e., downward comparison). These findings revealed the temporal characteristics of neural activity in social comparison and fairness consideration, complimenting previous fMRI studies that localized brain regions involved in social comparison (Dvash et al., 2010; Haruno and Frith, 2010; Tricomi et al., 2010) and fairness consideration (Sanfey et al., 2003; Tabibnia et al., 2008; Güroglu et al., 2010).

Previous studies suggest that upward comparison, i.e., being worse off than others, is motivationally salient and threatens self-esteem, causing individuals to feel inferior to the others (Wood, 1996). Such negative emotions elicited by upward comparison might drive the recipients to reject more often the division schemes, whether the offers are highly or moderately unequal and even though such costly punishment of the allocators might lead them and the allocators both empty-handed. Nevertheless, this effect of social comparison was more pronounced when the offers were highly unequal. Upward comparison deepens the experienced negative feeling caused by the unequal offers deviating from the equity rule in asset distribution, leading to more rejections to the division schemes. This finding is consistent with Bohnet and Zeckhauser (2004) which demonstrated that social comparison facilitates recipients' attention to the fairness norm.

The finding of a MFN effect, with more negative-going responses to highly unequal offers than to moderately unequal

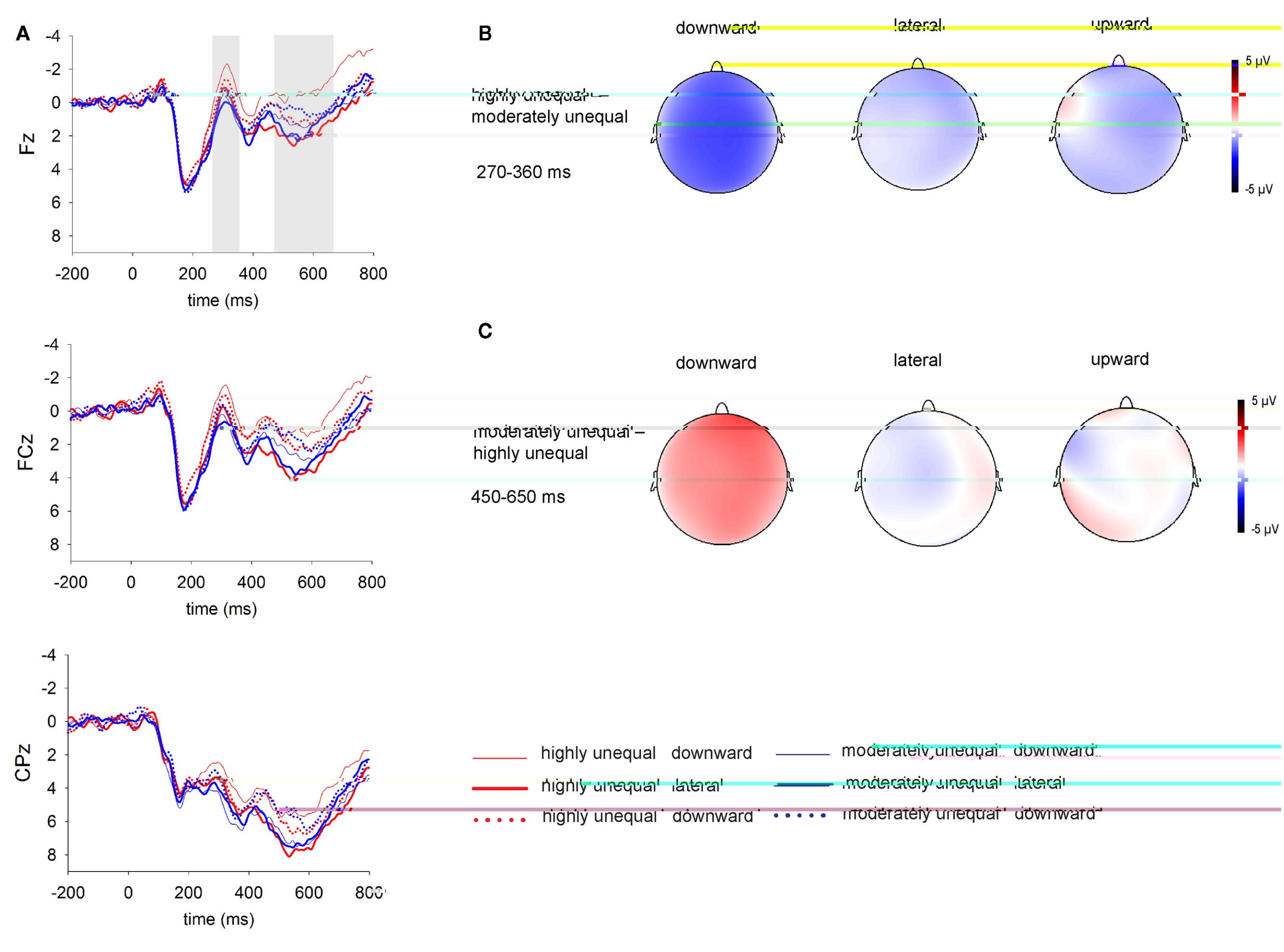

FIGURE 3 | (A) ERP responses time-locked to the onset of different offers at the midline Fz, FCz, and CPz. The shaded 270–360 ms time window was for the calculation of the mean amplitudes of the MFN. The shaded 450–650 ms time window was for the calculation of the mean amplitudes of the LPP; **(B)** topographic maps for the MFN effect; **(C)** topographic maps for the LPP effect.

offers, replicated previous studies in which the MFN effect increased with unfairness in economic games (Polezzi et al., 2008; Boksem and De Cremer, 2010; Hewig et al., 2011; Wu et al., 2011; Van der Veen and Sahibdin, 2011). This effect may reflect the detection of social expectancy violation as egalitarian distribution of assets is an expected social norm (Messick and Sentis, 1983; Fehr and Gächter, 2002; Fehr and Fischbacher, 2004). During evolution, the human brain may have developed specific mechanisms to detect ongoing deviations from social norms (Montague and Lohrenz, 2007). These mechanisms might share the same neural correlates as those engaged in predicting errors during non-social reinforcement learning (Harris and Fiske, 2010). The MFN can therefore reflect not only the encoding of prediction errors for monetary reward or performance feedback but also violations of expectancy toward social norms.

A perhaps surprising finding in this study was that social comparison had no obvious effect on the MFN responses to division schemes. This absence of a social comparison effect appears to be at odds with Boksem et al. (2011) and Qiu et al. (2010) in which social comparison modulated the MFN or MFN-like responses in outcome evaluation. It is possible that the discrepancy between these findings is due to different paradigms employed in the studies. In both Boksem et al. (2011) and Qiu et al. (2010), the participants performed a gambling task in which one's own outcome as well as the other's were presented simultaneously and the outcome for the participant was deterministic. In a recent study, Wu et al. (2011) also found that the social distance between the allocator and the recipient, i.e., being friends vs. strangers, could modulate MFN responses to equal and unequal offers in the dictator game (DG). DG is similar to UG except that the recipient owns no right but has to accept any offer from the allocator. This finding, together with Boksem et al. (2011) and Qiu et al. (2010), suggests that the social context can affect the MFN responses when reward is deterministic. However, in the UG paradigm adopted here, as the participants can decide to either accept or reject the offers, the outcome is negotiable. The (un)certainty of the outcome may affect the extent the participants process the affective/motivational significance of the outcome. The system may adopt a "wait-and-see" strategy and conduct deeper assessment of offers only at a later stage involving more top-down processes (Cunningham et al., 2003; Leng and Zhou, 2010; Ma et al., 2011). That is, fairness consideration in UG can be differentiated into two stages: an earlier, semi-automatic stage in which the fairness of offers are considered at an abstract level with reference to long-established social norms but without much reference to personal interests; and a later, cognitive appraisal stage in which social factors comes into play (Moore and Loewenstein, 2004; Wu and Zhou, 2009; Leng and Zhou, 2010).

Recent ERP studies employing economic games have indicated that the P300 is sensitive to different offers, with its magnitude less positive to unequal offers (Wu et al., 2011). In the present study, we found the late positivity potential (LPP), rather than the P300, was

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